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R WATERSHED PROTECTION AND FLOOD PREVENTION

TURKEY CREEK WATERSHED

Dickinson and Marion Counties, Kansas

MARCH 1965

OUR SOIL ★ OUR STRENGTH

USDA-SCS-LINCOLN, NEBR 1965

WATERSHED WORK PLAN

TURKEY CREEK WATERSHED

Dickinson and Marion Counties, Kansas

Prepared Under the Authority of the
Watershed Protection and Flood Prevention Act
(Public Law 566, 83rd Congress; 68 Stat. 666), as amended

Prepared by

Dickinson County Soil Conservation District
Marion County Soil Conservation District
Turkey Creek Watershed Joint District No. 32

With Assistance by

U. S. Department of Agriculture
Soil Conservation Service
Forest Service

State of Kansas
State Soil Conservation Committee

March 1965

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SUMMARY OF PLAN

This plan for watershed protection and flood prevention is sponsored by the Turkey Creek Watershed Joint District No. 32 and the Dickinson and Marion County Soil Conservation Districts. Technical assistance in preparing the watershed work plan was provided by the Soil Conservation Service, United States Department of Agriculture. The Soil Conservation Service negotiated a contract with Bucher and Willis, Engineers, Salina, Kansas, to collect and process engineering data. The State of Kansas, through the State Soil Conservation Committee, provided funds for these services.

Turkey Creek Watershed, with a drainage area of 168 square miles or 107,226 acres, is located in Dickinson and Marion Counties in central Kansas. It is a south bank tributary of the Smoky Hill River entering that stream just below the town of Abilene, Kansas.

Floodwater damage to crops, land, other agricultural property, and roads and bridges are the principal watershed problems. Average annual flood damages in the watershed under existing conditions are estimated to be $192,400. The average annual damage after project installation, including land treatment and structural measures, is estimated to be $73,100. The difference of $119,300 represents an over-all average annual reduction in flood damages of 62 percent.

Works of improvement will include needed land treatment measures together with structural works consisting of 15 floodwater retarding structures and 28.35 miles of channel improvement. The reservoirs will have a total capacity of 14,799 acre feet of which 12,407 acre feet are for detention storage and 2,392 acre feet are for sediment storage. This system will regulate runoff from a drainage area of 64.7 square miles which is 39 percent of the watershed area. Channel improvement consists of snagging and brushing to improve the in-bank flow characteristics.

A period of 10 years is proposed for installing the needed works of improvement at an estimated total cost of $2,755,400. $1,528,000 will be Public Law 566 funds and $1,227,400 will be from other sources.

The cost of the land treatment measures for watershed protection is estimated at $1,090,200. The share from P.L. 566 funds, consisting entirely of technical assistance is $73,900. The share from other funds is estimated at $1,016,300. Cost sharing and technical assistance available under other programs will be utilized in applying these measures.

The total cost of all structural measures is $1,665,200 of which $1,454,100 will be borne by P.L. 566 funds and $211,100 by local interests.

Total average annual benefits of the project are $157,400, of which $24,500 are attributed to land treatment measures and $132,900 result from structural measures. Damage reduction by works of improvement will result in benefits of $119,300 within the watershed. Benefits accruing from changed land use are $6,400 and from more intensive use are $13,600. Benefits of $2,200 accrue to the project from the flood plain lying below the watershed boundary. Secondary benefits of $13,900 will be realized from the project. Additional recreation benefits from hunting and fishing will be realized from the project but were not evaluated monetarily or used for justification of this plan.

The ratio of the total average annual benefits from structural measures, $132,900, to the average annual costs, $71,500, is 1.9 to 1.0.

Turkey Creek Watershed Joint District No. 32 will provide land easements and right-of-way and will contract for construction of the structural measures. The Watershed District Act requires the method of financing be adopted concurrently with the adoption of the general plan.

Land treatment measures will be maintained by landowners and operators of the farms on which measures are installed. This will be accomplished by agreement with the Dickinson and Marion County Soil Conservation Districts.

Floodwater retarding structures and channel improvement will be operated and maintained by the Turkey Creek Watershed Joint District No. 32 at an estimated average annual cost of $5,200.

DESCRIPTION OF THE WATERSHED

Physical Data

Turkey Creek Watershed lies on the south side of the Kansas River in east central Kansas. The watershed boundary includes an area of 168 square miles or 107,226 acres. About 18,500 acres are in Marion County and 88,726 acres are in Dickinson County. This area is about 25 miles long and averages about 9 miles in width.

Turkey Creek begins in Marion County about 5 miles south of the county line, flows north, and discharges into the Smoky Hill River just south of Abilene, Kansas.

Elevations range from 1,435 feet above sea level in the uplands of the watershed to 1,130 feet at the lower end, giving a total fall of 305 feet. Slopes are less in the upper half of the watershed than in the lower half. This is true of both the channel and valley side slopes.

Sandy soils in reaches 6, 7, and M-1 (see project map for location) are developed over underlying sandstone. The rest of the upland soils are claypan developed over underlying shale. The bottomland soils are friable silty to clay loams.

Land capability of the extreme southwest part of the watershed, consisting of less than 10 percent of the upland area, is Class VI. This area is very rolling and is primarily grassland. The flood plain is made up of land in capability Classes I and II with the major portion being Class I. The remaining upland is primarily in land capability Classes II, III, and IV with Class II appearing on the divides and Class IV on the steeper breaks.

It is estimated that there are 1,300 acres of land in capability Class VI presently being used for cropland that should be seeded down to permanent grass. In addition there are 46,000 acres of cropland that have a serious erosion problem that will require mechanical, vegetative, and managerial land treatment practices.

Approximately one-third of the total needed land treatment practices have been applied. Applied practices, their amounts, and costs are shown in table 1a, page 20.

Land use consists of approximately 69 percent cropland, 27 percent native grassland, 1 percent woodland, and 3 percent miscellaneous. About 75 percent of the native grass pastures are in fair condition and the remainder are in poor condition. Woodlands occupy approximately 1,000 acres. Hydrologic conditions in these woodlands are generally good to excellent.

The majority of the forest land is located in narrow belts along Turkey Creek and its tributaries. These woodlands consist mainly of small scattered ownerships of less than 40 acres. Some of the species commonly found are black walnut, soft maple, bur oak, cottonwood, hackberry, green ash, elm, sycamore, and honey locust. These stands are generally fully to over-stocked, but tree quality and species composition are often poor.

The mainstem of Turkey Creek provides opportunity for warm water fishing. The timbered areas adjacent to the mainstem and tributaries provide excellent cover for both upland birds and small game.

Channel capacities vary from 13-17 c.s.m. in reaches 1, 2, 3, 4, and 5. The channel is characterized by many fallen trees and drift wood which presently cause restricted flow.

Average annual precipitation for Salina, Kansas, located 25 miles northwest of the watershed is 29.50 inches. The largest total annual

precipitation recorded at Salina is 49.66 inches in 1951 and the smallest is 15.81 inches in 1956. Normally about 75 percent of the precipitation falls during the growing season, April to October. The average growing season is 173 days. The average date of the first frost is October 15 and the average frost free date is April 25. The highest temperature recorded is 118 degrees F and the lowest temperature recorded is -31 degrees F.

<u>Economic Data</u>

The family farm predominates in the watershed area. There are close family ties because of people being blood related or related through marriage. Father-son or other family arrangements can be found in a number of farming operations. The proportion of tenancy is approximately 25 percent.

The area is typically rural America in most of its social, spiritual, and cultural aspects. Community life for the most part continues to be centered around the rural churches, schools, and small towns. The rural New Basel Church gymnasium, the rural Center Elementary School, and church halls provide facilities for many of the community activities.

There are about 320 farms in the watershed averaging 360 acres in size. Upland pasture is valued at 100 dollars per acre, upland cropland is worth 125 dollars per acre, and flood plain cropland is valued at about 250 dollars per acre.

Most of the farms in the watershed are diversified raising primarily corn, wheat, grain sorghums, and alfalfa. Wheat is the major cash crop with most of the other grains and hay marketed through livestock.

Land use is as follows:

Land Use	Watershed Total	Flood Plain
Cropland	73,596	6,491
Pasture	28,993	160
Woodland	1,052	962
Miscellaneous	3,585	401
Total	107,226	8,014

Practically none of the woodlands have received any type of management in the past. Investigations show that "high-grading" -- consistently cutting only the best -- has been a common practice. As a result, many of these sites are characterized by the domination of lower value species and there is little economic return. However, most of these woodland sites are rated "very high" potential in terms of growth rates for high value species such as walnut, soft maple, and bur oak.

Because of easy accessibility and general absence of steep grades in the woodlands, logging problems are minor.

Soil Conservation District programs in Dickinson and Marion Counties are popular and aggressive. Present demand for available technical and cost-sharing assistance required for the installation of land treatment measures would encumber the current level of assistance for the next 2 1/2 years.

Navarre, with a population of approximately 280, is the only town within the watershed boundary. Some of the population centers within 30 miles of the watershed are: Salina 43,202; Abilene 6,746; Junction City 18,700; and Herington 3,702. These and other nearby towns provide adequate market facilities.

The Missouri Pacific, Atchison Topeka and Santa Fe, and the Chicago Rock Island and Pacific Railroads serve the market facilities of the area.

The system of roads shown on the project map provides access to all parts of the watershed. The road system is considered adequate except when interrupted by high water or flood damage.

Two summer camps are located within the watershed. Marydell Camp is a Methodist camp located on the east side of Turkey Creek just above its junction with the Smoky Hill River. Brown Memorial Camp is a Boy Scout camp located across the creek from the Marydell Camp. Portions of both camps are damaged during flood flows.

Turkey Creek outlets into the Smoky Hill River within two miles of Abilene, Kansas. This is the site of the Eisenhower Home, Museum, and Library as well as other items of historical interest. It is a popular tourist attraction with Interstate-70 leading into Abilene from east to west. Highway K-15 runs south out of Abilene through the watershed.

The farm lands in the watershed will be further enhanced as watershed protection and flood prevention measures are installed.

There will be many possibilities for recreational developments and community beautification; consequently, all this can present opportunities for promoting rural areas development effort. It can afford the tourist and others the opportunity to enjoy the diversity of scenery in the sub-humid area of the Mid-west.

WATERSHED PROBLEMS

Floodwater Damage

Damage resulting from the flooding of flood plain lands and facilities is the principal problem. The entire Turkey Creek bottom is flooded

frequently. The largest flood on record occurred in July 1951. On the average three flows a year exceed bank full capacities. Flooding usually occurs during the growing season.

The flood plain covers 8,014 acres and includes 6,491 acres of cropland valued at $250 per acre. Crop damage due to flooding averages $128,800 annually and accounts for 67 percent of the total flood damage. Flooding is usually of short duration with high velocity flows the major cause of flood damage.

Flooding causes damage to buildings, fences and machinery. Many miles of fences are destroyed or damaged even by minor floods. Most buildings have been moved out of the flood plain because of the frequency of flooding; however, such installations as cattle and hog pens, feed bunks, and stock tanks are frequently damaged. Considerable expense is incurred for clean up of debris after flooding. Agricultural damage of this type averages about $17,600 annually.

Floodwater damage to roads and bridges is extensive, amounting to $23,600 on an average annual basis. Flood flows wash away road surfacing, scour road shoulders, silt in roadside ditches, and damage bridges. County and township road budgets are not usually sufficient to make immediate replacements and repairs following a flood. Such costs and needed work are spread over a number of years allowing these essential facilities to remain in a subnormal condition.

Small frequent floods, localized in character, cause considerable damage and inconvenience to farmers in the area of their occurrence. A major flood such as that experienced in 1951 affects everyone in the area due to damage to roads, bridges, transportation, utilities, and loss of business to those serving the agricultural community. Such indirect losses under present conditions are estimated to average $18,100 annually.

Erosion Damage

Damage to cropland has been moderate to severe. It is estimated that 6 percent of the flood plain is damaged to an extent ranging from 24-43 percent. Crop yields have been reduced because of erosion. Production costs have increased due to the reduction in fertility and the need for larger amounts of fertilizer. The ability of the soil to hold moisture has also been reduced due to the amount of erosion. Average annual erosion damage to the flood plain under present conditions is estimated to be $4,300.

Upland erosion on sloping cropland constitutes a serious problem. Conservation measures, where applied, have been effective in controlling this erosion.

Sediment Damage

Damage from sediment deposition on flood plain land is not a serious problem. Sediments are mainly silts and clays and have only slight detrimental effects on flood plain lands. Channel agradation is not a problem.

Sediment deposition in road ditches and ponds is a problem below untreated upland cropland fields.

Problems Relating to Water Management

Drainage is not a problem needing project type programming.

There is some interest in irrigation but not to the extent of cost sharing for additional water storage.

There has been interest in the improvement of fish and wildlife habitat, but again not to the extent of cost sharing for additional storage. Improved fish and wildlife habitat will be a by-product of the proposed structures.

PROJECTS OF OTHER AGENCIES

The Corps of Engineers, Kansas City District, studied a reservoir on Turkey Creek for multiple-purpose development in connection with their "Review Report on the Kansas River", September 1960. This report found that the Turkey Creek reservoir could not be justified by the presently foreseeable benefits.

BASIS FOR PROJECT FORMULATION

The desire of the local sponsoring organization is to reduce to the greatest degree economically possible, floodwater damage to the land, crops and other valuable properties within the flood plain. This must be accomplished with the least possible encroachment on flood plain land which constitutes the heart of a balanced agriculture in the watershed.

Topography of the watershed provides numerous sites for dam construction. Roads, pipelines, utilities, railroads, farm buildings, etc. were physical and economic factors influencing the selection of structure sites. A system of physically feasible and economically justified tributary structures was formulated to provide the highest degree of flood protection economically sound based on tributary control.

Inclusion of mainstem structures to provide increased benefits in the lower reaches would not offset the loss of benefits in the upper reaches and in the reservoir areas of such structures. Channel improvement was included through reaches 1, 2, 3, 4, and 5 to further decrease damages in these reaches.

WORKS OF IMPROVEMENT TO BE INSTALLED

Works of improvement to be installed consist of the necessary land treatment measures for watershed protection plus 15 floodwater retarding structures and 28.35 miles of channel improvement (See table 1).

Land Treatment Measures

Application of land treatment measures is essential to a sound and continuing watershed protection and flood prevention program. This is accomplished by the establishment and maintenance of all soil, water, and plant management practices essential for each land use. The result will be a reduction in runoff rates, erosion damages and sediment yield.

Standard soil surveys will be completed over all the watershed. These surveys were started in the latter part of 1964 and with planned acceleration funds are scheduled for completion early in the construction period.

Farmers and ranchers cooperating with the soil conservation district will develop conservation plans that will achieve proper land use and meet the basic conservation needs of the land. The trend will be to continue rangeland in that land use with improvement being made in the condition of some ranges. A small amount of cropland will be converted to rangeland and pastureland, plus some conversion to water storage in reservoirs. The trend on cropland is for more close growing crops and fewer row crops.

Treatment on the cropland will include conservation cropping systems, grassed waterways, terraces, contour farming and crop residue use, plus feasible fertilizer programs. Technical assistance will be required primarily on the first three practices. This treatment will be essential on the relatively large acreage of cropland on the upland above the floodwater retarding structure sites.

Treatment on the rangeland will include proper range use, construction of stockwater ponds, deferred grazing, and management practices to achieve proper grazing distribution. A high percent of the rangeland is being properly used. Greatest overuse occurs during drouth years.

Treatment of woodland sites will include tree and shrub planting, improved forestry practices, and grazing control. These are planned in order to maintain or improve hydrologic conditions of the woodland sites.

Fire control activities are planned to protect all vegetative cover from destructive wildfires. These activities will be strengthened and maintained through the going program and will include the acquisition of additional pumping and handtool equipment.

Amounts and estimated costs of land treatment to be applied during the project period are shown in table 1. The estimated total cost of

soil surveys, planning and installing the land treatment measures is $1,090,200. Public Law 566 funds will be furnished in the amount of $73,900 to provide technical assistance to accelerate the current program. Funds from other sources will be provided in the amount of $1,016,300 for installing these measures.

Structural Measures

A system of 15 floodwater retarding structures will be installed and 28.35 miles of channel will be improved at the locations shown on the project map. Features of a typical floodwater retarding structure with principal spillways having two stage inlets are shown on page 38. A drawing of a typical channel cross section showing planned channel improvement is shown on page 39. Physical data for floodwater retarding structures is presented in table 3.

The system will provide 12,407 acre feet of floodwater detention storage, 2,392 acre feet of sediment storage for a total of 14,799 acre feet. This system of structures will control the runoff from 64.7 square miles. This is 39 percent of the watershed area.

Floodwater retarding structures have been planned with a floodwater storage ranging from 3.15 to 4.05 inches of runoff from their drainage areas. Storage will be provided for the expected 50-year accumulation of sediment with a storage volume equivalent ranging from 0.49 to 1.34 inches per acre from the drainage area above detention structures.

Floodwater retarding structures will be earth dams with two-stage inlets in the principal spillways. The principal spillways will be reinforced concrete or a comparable quality material. They will have an uncontrolled release rate of 10 c.s.m. through the lower stage with an additional 10 c.s.m. through the upper stage. Vegetated emergency spillways will be provided to release runoff exceeding reservoir storage capacity safely past the embankment. These spillways have been planned so that their chance of operation in any one year is 4 percent or less.

Channel improvement will consist of snagging and clearing of drift, debris and woody vegetation from the stream channel. This will increase channel capacity by lessening the resistance to the flow of water. Channel improvement will increase the average bankful capacity by 43 percent. The State Extension Forester will provide technical assistance for utilization of commercially valuable trees and for cutting prescriptions based on sound forest management principles which also meet the general improvement objectives.

The estimated cost of floodwater retarding structures is $1,540,900, and of channel improvement is $124,300 giving a total structural measures installation cost of $1,665,200. Individual structural measure costs are shown in table 2.

EXPLANATION OF INSTALLATION COSTS

Amounts and estimated costs of the land treatment measures are shown in table 1. The estimated total cost of planning and installing these land treatment measures is $1,090,200. It is estimated that $11,600 will be needed for standard soil surveys. Of this, $6,000 will be needed for acceleration and will be paid for from P.L. 566 funds. Public Law 566 funds will be furnished in the amount of $73,900 to provide technical assistance to accelerate the current program. Funds from other sources will be provided in the amount of $1,016,300 for installing these measures.

Public Law 566 costs for structural measures for flood prevention includes construction cost and installation services cost. Construction cost includes general construction and vegetative establishment of the nature normally performed by contractors. Installation services include engineering, administrative service and overhead costs of programming and supervision.

Engineering services include all direct and related costs of the services of engineers and geologists for surveys, geologic site investigations, soil mechanics, structure design, construction plans and specifications, and construction supervision and engineering. Administrative services include assistance rendered to the local contracting organization in preparing invitations to bid and in awarding construction contracts. Overhead costs include administration and program supervision at all levels of the installation program.

Engineering services costs were computed as a percent of construction cost where functions are proportional to construction cost. Functions with relative fixed costs were computed at flat rates. Administrative services costs were computed at 8 percent of construction cost.

Construction cost estimates in this plan are based on computed quantities derived from survey data, using unit costs from similar work on watershed projects currently under construction with a contingency allowance of 12 percent. At the time of project installation, additional surveys will be needed at the dam sites as a basis for structural design and construction cost estimates. Geologic drilling and soil mechanics tests and analysis will be performed to verify site and foundation conditions. Reservoir storage volumes will be computed from topographic maps made during work plan preparation.

Land, easements, and rights-of-way values were determined by the board of directors of the Turkey Creek Watershed Joint District. Cost estimates were based on current land values of $100 per acre for grassland, $125 per acre for upland cropland and $250 per acre for bottom cropland. These values may not coincide with actual out-of-pocket costs to the local sponsoring organization because some easements and rights-of-way may be obtained by donation.

Contract administration costs of the local contracting organization will include cost of mailing bid invitations, salary, and expenses of the contracting officer in administering construction contracts. Contract administration costs were estimated on the basis of experience of other watershed districts in Kansas which have carried out construction work.

Estimated total P.L. 566 structural cost and other obligations by fiscal years during the project installation period are as follows:

Fiscal Year	P.L. 566 Costs	Other Costs	Total
First	100,490	110,530	211,020
Second	243,790	139,830	383,620
Third	273,790	123,630	397,420
Fourth	7,390	101,630	109,020
Fifth	7,390	101,630	109,020
Sixth	7,390	101,630	109,020
Seventh	141,090	115,630	256,720
Eighth	204,790	146,530	351,320
Ninth	249,390	122,130	371,520
Tenth	292,490	164,230	456,720
Total	1,528,000	1,227,400	2,755,400

Cost of applying land treatment measures is based on current costs of applying such measures under going programs.

EFFECTS OF WORKS OF IMPROVEMENT

The flood prevention program will directly benefit 320 farm families. The program of land treatment and structural measures will reduce flood damage ranging from 100 percent immediately below floodwater retarding structures to 51.2 percent at the outlet of the watershed. The program will accomplish a 61 percent reduction in average annual flood damages within the watershed. Area benefited and percent reduction of damages by reach are shown in the following table:

Reach (Project Map)	Area Benefited in Acres	Percent Reduction in Damage
1	836	51.2
2	921	53.5
3	740	52.2
4	901	55.7
5	531	59.0
6	982	59.9
7	129	94.1
E-1	473	50.5
E-2	468	90.7
E-3	340	90.0
M-1	460	80.2
W-1	805	67.1
W-2	39	95.6
Total	7,625	61.3

The map on page 13 shows the program effect on the May 1961 storm. This aerial view of the flood plain shows part of subwatershed 2 from near the Pat Huston farm upstream near the Kenneth Hassler farm. The super-imposed lines and cross hatching show flooded area with and without the watershed program. The flooded area shown was reduced from 159 acres to 24 acres or a reduction of 85 percent. For those subwatersheds lying upstream, the percent reduction would be increased and for those downstream the percent reduction would be slightly decreased.

Reduction in the depth and frequency of flooding will substantially reduce crop losses. Reduction in the flood hazard will induce farmers to use more fertilizer, improved crop varieties, and establish soil building rotations. Farmers will be able to perform tillage, planting, and harvesting operations on a timely basis for improved production.

Losses in productivity due to removal of soil by flood plain scour will be substantially reduced. Reduction in flooding will likewise make it possible to restore productivity on previously damaged land at a more rapid rate.

A substantial reduction in costs of maintaining roads and bridges on the flood plain will be realized. The reduction in cost of repairing flood damages will release road and bridge funds for use in improving and modernizing the existing road system.

The watershed project will bring about a land use adjustment. A more complete job of conservation farming on the upland will cause a conversion of some cropland to pasture. A reduction in frequency of flooding on the flood plain will allow 641 acres of land now in brushy

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

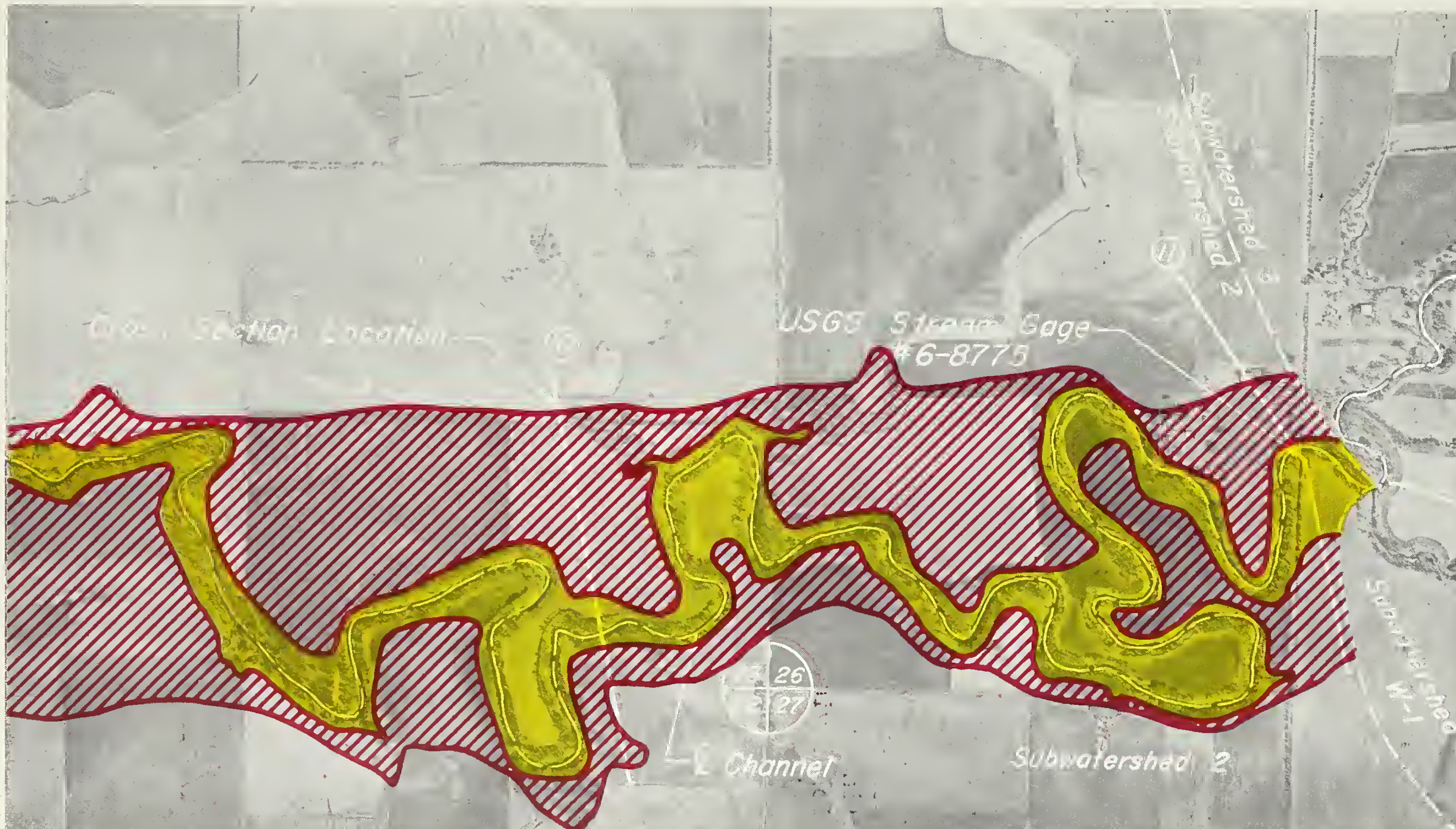
FIGURE I

TURKEY CREEK WATERSHED-DICKINSON & MARION COUNTIES KANSAS

AREA FLOODED WITH AND WITHOUT PROJECT

IN SUBWATERSHED 2

MAY 1961 STORM



AREA FLOODED WITHOUT PROJECT

AREA FLOODED WITH PROJECT INSTALLED

SCALE IN FEET

600 0 600 1200

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pasture and timber to be converted to cropland. Construction of the 15 floodwater retarding structures will convert both pasture and cropland to water storage in the sediment pools.

Works of improvement will provide benefits to 25,300 acres below the watershed boundary. These benefits have been coordinated with the Kansas Water Resources Board; Corps of Engineers, Kansas City District; and the Soil Conservation Service. Benefits from the reduction of flooding will accrue along the mainstem of the Smoky Hill River from the mouth of Turkey Creek to its junction with the Republican River.

Secondary benefits stemming from the project are realized from transporting, processing and marketing agricultural commodities produced as a result of reducing crop losses by flooding. Secondary benefits induced by the project include the increased net return to suppliers of farm equipment and materials required to achieve the increased agricultural production made possible by the project, the increased net return to local retailers and wholesalers from consumer expenditures by the farm family resulting from increased farm income, and any other increase in net returns resulting from costs directly associated with marketing or using project goods or services. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Recreational benefits in Turkey Creek Watershed will accrue to the public. There are 15 floodwater retarding reservoirs with sediment pools ranging in size from 12 to 49 acres with a total of 449 acres. These pools will afford recreational facilities of fishing, boating, and hunting. In addition, camping facilities will be available in the area surrounding this water.

A general benefit to the fish resources of the area is expected. Stream fishing will be improved as a result of more stabilized flows below the floodwater retarding structures. Permanent storage pools in the floodwater retarding reservoirs will increase the fishing opportunities in the watershed. Increased water area of some 449 acres widely distributed over the watershed will benefit waterfowl by providing resting areas and some winter habitat. Upland game birds will be displaced from the permanent pool area of the detention structures, but terrestrial species will benefit from flood reduction in the protected bottomlands where not intensively cultivated. Landowners and operators will be encouraged to include wildlife conservation practices along with other conservation measures on their land.

PROJECT BENEFITS

Benefits of \$157,400 accrue to flood prevention. Of these \$24,500 accrue to land treatment and \$132,900 are attributable to structural measures. Individual items of benefit are shown in table 6.

Average annual damage reduction benefits with the project installed total $119,300. Individual items are shown in table 5. Benefits from reduction in floodwater damage to crops and pasture average $79,600 annually and account for 51 percent of the flood prevention benefits. Reduction in flooding achieves benefits of $11,600 to other agricultural property such as stored feed, fences, buildings, and other farm improvements and benefits to roads and bridges in the amount of $14,900 on an average annual basis.

Benefits from reducing damages to flood plain land by scour will average $1,800 annually, accounting for about 1 percent of the total flood prevention benefits. Indirect average annual benefits realized from reduction in interruption of travel, halting or delays in mail, school busses, and milk routes amount to $11,400.

Reduction of the flood hazard makes possible benefits from more intensive use of land through improved crop rotations and use of fertilizers amounting to $13,600 annually and benefits from changed land use amounting to $6,400 annually.

The annual value of local secondary benefits stemming from the project is $13,000 and the value of secondary benefits induced by the project worth $2,900 giving a total value of $15,900.

Flood prevention benefits outside of the watershed attributed to Turkey Creek works of improvement average $2,200 annually.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of structural measures, including installation, operation and maintenance is $71,500. When the project is installed, the structural measures will produce average annual primary benefits of $119,000. Therefore, the project will produce primary benefits of $1.70 for each dollar of equivalent cost (see table 6). The benefit cost ratio based on total benefits of $132,900 is 1.9 to 1.

PROJECT INSTALLATION

Works of improvement will be installed in a 10-year period. Federal assistance for carrying out the works of improvement on non-Federal land as described in this work plan will be provided under Public Law 566, 83rd Congress, 68 Stat. 666, as amended.

Land Treatment Measures

Land treatment measures listed in table 1 will be established on land by the farm owners and operators in cooperation with Dickinson and Marion County Soil Conservation Districts. The owners and operators of the land will stand the cost of needed land treatment measures and the

Soil Conservation Service and the Kansas State Extension Service through cooperative agreement with the U. S. Forest Service will provide technical assistance as needed. Technical assistance to the Soil Conservation Districts will be increased to insure that adequate assistance will be available to the landowners for an accelerated application of land treatment.

The Extension Service will assist in carrying out the educational phase of the program by preparation of general information in cooperation with the governing bodies of the Soil Conservation and Watershed District boards. The Farmer's Home Administration soil and water loan program will be available to eligible farmers in the area. The County Agricultural Stabilization and Conservation Committees will cooperate with the governing bodies of the Soil Conservation Districts to accelerate Agricultural Conservation Program financial assistance for those practices which will accomplish the conservation objectives. The supervisors of the Dickinson and Marion County Soil Conservation Districts will encourage landowners and operators within the Turkey Creek Watershed to install soil and water conservation measures on their farms.

Structural Measures

The Turkey Creek Joint Watershed District will contract for the construction of 15 floodwater retarding structures and 28.35 miles of channel improvement. Structural measures will be installed through construction contracts awarded on the basis of competitive bidding. Separate contracts will be awarded for general construction and for vegetative establishment. The Turkey Creek Joint Watershed District will appoint a contracting officer and will bear the cost of contract administration.

The Watershed District will obtain land rights, easements, and rights-of-way needed for installation of the structural measures. They have power of eminent domain to obtain land rights for public improvements and have agreed to use such authority when needed. The Watershed District will make arrangements with the county commissioners for abandonment, relocation, or modification of any county road requiring such action. They will likewise arrange for any relocation or modification of pipelines, communication lines, or other public utilities which are necessary in connection with project installation.

After Federal assistance is authorized for installation of the project, the Soil Conservation Service will furnish engineering services to prepare construction plans and specifications for structural measures for flood prevention. Construction can be started on structures when all necessary land treatment has been completed, land easements and rights-of-way have been obtained, P.L. 566 funds are available, and local sponsoring organizations have complied with State laws relating to approval of construction plans.

FINANCING PROJECT INSTALLATION

The Turkey Creek Joint Watershed District was created and validated in accordance with the Kansas Watershed District Act as amended. The watershed district has all the necessary authority and powers to finance and carry out watershed improvements. These powers include the right to accept contributions, levy taxes, make assessments against land specially benefited, issue bonds, and exercise the right of eminent domain.

Expenses of organizing the watershed district have been paid and current general expenses are being met by an annual ad valorem tax levy.

The watershed district has been furnished land rights work maps for all structural measures as a basis for contacting landowners and appraising costs to the district. Land rights will either be donated or purchased by the local people. Land rights which must be purchased will be financed by a general tax levy.

Funds for construction costs will be provided to the local sponsoring organization as grants-in-aid through project agreements for construction executed with the Soil Conservation Service. Each construction contract will have a project agreement.

Federal technical assistance, installation service, and grants-in-aid for construction are contingent upon appropriation of funds for these purposes.

Soil Conservation Districts will seek allocation of Agricultural Conservation Program funds as are needed to cost share on land treatment measures to meet project objectives within the watershed. Technical assistance available from the Soil Conservation Service in its program of assistance to soil conservation districts will continue at current rates.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

The land treatment measures will be maintained by the landowners and operators of the farms on which the measures are installed under agreements with the Soil Conservation Districts serving the watershed. Representatives of the soil conservation districts will make periodic inspections of the land treatment measures to determine maintenance needs and will encourage landowners to perform needed maintenance.

Structural Measures

An agreement providing for operation and maintenance of the structural measures will be executed by the local sponsoring organizations before Federal construction funds are made available.

The 15 floodwater retarding structures and 28.35 miles of channel improvement will be operated and maintained by the Turkey Creek Joint Watershed District. All structural measures will be inspected by representatives of the watershed district and Soil Conservation Service at least annually and after each heavy runoff producing storm. Items of inspection will include but not be limited to the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and emergency spillway, fences installed as a part of the structural measures, and vegetation and drift in the improved channel. The Turkey Creek Joint Watershed District will maintain a record of maintenance inspections.

Maintenance work will be carried out when needed. Kinds of maintenance work that would be expected rather frequently are repairs to fences, clearing of debris, mowing of dam and spillway, spraying weeds and brush in improved channel etc. Repairs to major construction items such as the dam and spillway are expected very infrequently.

The estimated average annual operation and maintenance cost is $5,200. The necessary maintenance will be accomplished through contributed labor and equipment and/or hired labor and equipment. Funds for accomplishing the maintenance work will be obtained from an annual tax levy within the district.

Provisions will be made for free access of District, State, and Federal representatives to inspect the structural system at any time.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Turkey Creek Watershed, Kansas

Installation Cost Item	Unit	Number Non-Fed. Land	Estimated Cost (Dollars) 1/ P.L. 566	Other	Total
LAND TREATMENT					
Soil Conservation Service					
Cropland	Acres	49,200		933,000	933,000
Grassland	Acres	5,500		16,300	16,300
Technical Assistance			73,900	47,700 2/	121,600
SCS Subtotal			73,900	997,000	1,070,900
Forest Service					
Woodland	Acres	65		1,000	1,000
Fire Protection	Acres	100,900		18,000	18,000
Technical Assistance				300	300
FS Subtotal				19,300	19,300
TOTAL LAND TREATMENT			73,900	1,016,300	1,090,200
STRUCTURAL MEASURES					
Construction					
Floodwater Retarding Structures	No.	15	1,022,800		1,022,800
Channel Improvement	Mi.	28.35	95,200		95,200
Subtotal Construction			1,118,000		1,118,000
Installation Services					
Engineering Services			246,700		246,700
Other			89,400		89,400
Subtotal Instal. Services			336,100		336,100
Other Costs					
Land, Easements & R/W				206,000	206,000
Adm. of Contracts				5,100	5,100
Subtotal Other				211,100	211,100
TOTAL STRUCTURAL MEASURES			1,454,100	211,100	1,665,200
TOTAL PROJECT			1,528,000	1,227,400	2,755,400
SUMMARY					
Subtotal SCS			1,528,000	1,208,100	2,736,100
Subtotal FS				19,300	19,300
TOTAL PROJECT			1,528,000	1,227,400	2,755,400

1/ Price base 1964
2/ Includes $9,500 from watershed and soil conservation district funds

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Turkey Creek Watershed, Kansas

Measures	Unit	Applied To Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Soil Conservation Service			
Conservation Cropping System	Acre	25,290	26,600
Proper Range Use	Acre	3,900	3,900
Grass Waterways	Acre	1,281	147,300
Diversions	Mile	3	1,300
Terraces - Gradient	Mile	803	257,000
Water Developments 2/	No.	52	26,000
Drainage	Acre	320	10,500
Grade Stabilization Structures	No.	12	8,400
Forest Service			
Woodland Management and Improvement	Acre	20	400
TOTAL	xxx	xxx	481,400

1/ Price base 1964
2/ Includes farm ponds, spring development, wells and dugouts

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Turkey Creek Watershed, Kansas

(Dollars)1/

Structure Site No.	Installation Cost - P.L. 566 Funds				Installation Cost - Other Funds			Total Installation Cost
	Construction	Installation Services		Total P.L. 566	Adm. of Contracts	Easements & R/W	Total Other	
		Engineering	Other					
1	82,300	17,300	6,600	106,200	300	18,300 2/	18,600	124,800
2	67,000	16,100	5,400	88,500	300	7,600 3/	7,900	96,400
3	47,100	13,700	3,800	64,600	300	5,100 4/	5,400	70,000
4	63,900	15,900	5,100	84,900	300	25,700 5/	26,000	110,900
5	67,400	16,100	5,400	88,900	300	6,900	7,200	96,100
6	85,200	17,600	6,800	109,600	300	24,200 6/	24,500	134,100
7	42,400	12,700	3,400	58,500	300	4,100 7/	4,400	62,900
8	55,800	15,000	4,400	75,200	300	9,300 8/	9,600	84,800
9	42,200	12,600	3,300	58,100	300	5,200 9/	5,500	63,600
10	100,100	18,700	8,000	126,800	300	13,400	13,700	140,500
11	71,000	16,400	5,700	93,100	300	8,600	8,900	102,000
12	70,900	16,400	5,700	93,000	300	7,200	7,500	100,500
13	46,400	13,500	3,700	63,600	300	9,300 10/	9,600	73,200
14	35,000	11,100	2,800	48,900	300	9,000	9,300	58,200
15	146,100	21,100	11,700	178,900	300	43,700 11/	44,000	222,900
Structure Total	1,022,800	234,200	81,800	1,338,800	4,500	197,600	202,100	1,540,900
Channel Improve.	95,200 12/	12,500	7,600	115,300	600	8,400	9,000	124,300
TOTAL	1,118,000	246,700	89,400	1,454,100	5,100	206,000	211,100	1,665,200

1/ Price base - 1964
2/ Includes $6,962 to raise road and relocate power poles
3/ Includes $1,984 to raise road and dike around shed
4/ Includes $14,174 to raise road
5/ Includes $578 to raise road
6/ Includes $9,447 to raise road
7/ Includes $1,089 to raise road
8/ Includes $1,000 to move windmill
9/ Includes $2,500 to raise road and dike around sheds
10/ Includes $4,109 to raise road
11/ Includes $23,151 to raise road, relocate power and telephone lines and weight pipeline
12/ Cost is for tree clearing only

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TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES
Turkey Creek Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER 1	2	3
Drainage Area	Sq. Mi.	5.56	2.75	1.92
Storage Capacity				
Sediment	Ac. Ft.	225	136	102
Floodwater	Ac. Ft.	1,186	594	322
Total	Ac. Ft.	1,411	730	424
Between High and Low Stages	Ac. Ft.	587	299	199
Surface Area				
Sediment Pool	Acres	36	23	19
Floodwater Pool	Acres	147	76	65
Volume of Fill	Cu. Yds.	122,281	84,900	61,904
Elevation Top of Dam	Feet	1,263.0	1,250.7	1,299.6
Maximum Height of Dam	Feet	36.5	35.7	31.6
Emergency Spillway				
Crest Elevation	Feet	1,257.0	1,244.7	1,294.6
Bottom Width	Feet	130	60	40
Type	--	Veg.	Veg.	Veg.
Percent Chance of Use	--	2	2	4
Average Curve No. - Cond. II	--	80	81	79
Emergency Spillway Hydrograph				
Time of Concentration	Hrs.	2.25	1.25	0.75
Storm Rainfall (6 hours)	Inches	8.20	8.20	5.66
Storm Runoff	Inches	5.81	5.93	3.39
Velocity of Flow (Vc)1/	Ft./Sec.	5.9	5.9	2.8
Discharge Rate1/	c.f.s.	832	384	28
Maximum W. S. Elevation1/	Feet	1,259.3	1,247.0	1,295.3
Freeboard Hydrograph				
Storm Rainfall (6 hours)	Inches	14.1	14.1	8.24
Storm Runoff	Inches	11.49	11.61	5.72
Velocity of Flow (Vc)1/	Ft./Sec.	10.4	10.4	5.9
Discharge Rate1/	c.f.s.	4,550	2,100	256
Maximum W. S. Elevation1/	Feet	1,263.0	1,250.7	1,296.9
Principal Spillway				
Capacity - Low Stage2/	c.f.s.	55.6	27.5	19.2
Capacity - High Stage2/	c.f.s.	111.2	55.0	38.4
Capacity Equivalents				
Sediment Volume				
Below Crest of Prin. Splwy.	Inches	0.68	0.84	0.90
Above Crest of Prin. Splwy.	Inches	0.08	0.09	0.10
Total	Inches	0.76	0.93	1.00
Detention Volume	Inches	4.00	4.05	3.15
Spillway Storage	Inches	3.92	4.25	4.66
Class of Structure	--	b	b	a

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the peak capacity with the maximum head at the crest of the next stage.

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TABLE 3 - CONTINUED

STRUCTURE NUMBER					
4	5	6	7	8	9
3.82	3.04	8.82	1.48	4.69	2.15
167	217	296	79	165	61
662	527	1,529	316	812	373
829	744	1,825	395	977	434
403	321	931	156	495	227
45	29	49	18	30	12
136	80	206	54	112	54
77,182	86,586	103,003	59,210	63,104	48,623
1,307.2	1,342.7	1,347.8	1,388.7	1,321.7	1,381.8
26.2	37.5	35.8	27.7	28.7	30.0
1,302.2	1,337.7	1,341.9	1,383.7	1,316.6	1,376.8
40	60	100	40	80	60
Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
4	4	4	2	4	4
80	80	80	80	80	80
1.50	1.50	2.50	1.50	2.00	1.00
5.66	5.66	5.66	8.2	5.66	5.66
3.49	3.49	3.49	5.81	3.49	3.49
2.8	2.7	2.7	5.1	2.4	2.5
28	36	60	165	32	30
1,302.9	1,338.3	1,342.5	1,385.5	1,317.0	1,377.3
8.24	8.24	8.24	14.1	8.24	8.24
5.85	5.85	5.85	11.49	5.85	5.85
6.8	7.0	7.8	9.4	6.9	8.8
392	648	1,480	940	832	888
1,305.1	1,340.8	1,345.6	1,388.7	1,319.6	1,380.5
38.2	30.4	88.2	14.8	46.9	21.5
76.4	60.8	176.4	29.6	93.8	43.0
0.74	1.21	0.57	1.00	0.59	0.48
0.08	0.13	0.06	-0-	0.07	0.05
0.82	1.34	0.63	1.00	0.66	0.53
3.25	3.25	3.25	4.00	3.25	3.25
4.50	3.10	3.20	4.40	3.35	3.05
a	a	a	b	a	a

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES
Turkey Creek Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER 10	11	12
Drainage Area	Sq. Mi.	6.68	4.56	2.86
Storage Capacity				
Sediment	Ac. Ft.	210	119	110
Floodwater	Ac. Ft.	1,158	973	610
Total	Ac. Ft.	1,368	1,092	720
Between High and Low Stages	Ac. Ft.	705	482	302
Surface Area				
Sediment Pool	Acres	34	22	26
Floodwater Pool	Acres	143	112	90
Volume of Fill	Cu. Yds.	155,149	93,713	107,899
Elevation Top of Dam	Feet	1,370.7	1,389.9	1,316.9
Maximum Height of Dam	Feet	42.7	37.9	30.5
Emergency Spillway				
Crest Elevation	Feet	1,364.8	1,384.5	1,311.9
Bottom Width	Feet	100	100	105
Type	--	Veg.	Veg.	Veg.
Percent Chance of Use	--	4	2	2
Average Curve No. - Cond. II		80	80	80
Emergency Spillway Hydrograph				
Time of Concentration	Hrs.	2.50	1.50	1.50
Storm Rainfall (6 hours)	Inches	5.66	8.25	8.22
Storm Runoff	Inches	3.49	5.86	5.83
Velocity of Flow (Vc) 1/	Ft./Sec.	2.7	6.5	5.0
Discharge Rate 1/	c.f.s.	60	750	398
Maximum W. S. Elevation 1/	Feet	1,365.4	1,387.0	1,313.9
Freeboard Hydrograph				
Storm Rainfall (6 hours)	Inches	8.24	14.17	14.12
Storm Runoff	Inches	5.85	11.56	11.51
Velocity of Flow (Vc) 1/	Ft./Sec.	7.7	9.8	9.3
Discharge Rate 1/	c.f.s.	1,420	2,920	2,611
Maximum W. S. Elevation 1/	Feet	1,368.4	1,389.9	1,316.9
Principal Spillway				
Capacity - Low Stage 2/	c.f.s.	66.8	45.6	28.6
Capacity - High Stage 2/	c.f.s.	133.6	91.2	57.2
Capacity Equivalents				
Sediment Volume				
Below Crest of Prin. Splwy.	Inches	0.53	0.44	0.65
Above Crest of Prin. Splwy.	Inches	0.06	0.05	0.07
Total	Inches	0.59	0.49	0.72
Detention Volume	Inches	3.25	4.00	4.00
Spillway Storage	Inches	2.90	3.05	3.80
Class of Structure	--	a	b	b

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the peak capacity with the maximum head at the crest of the next stage

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TABLE 3 - CONTINUED

STRUCTURE NUMBER			
13	14	15	TOTAL
1.77	2.53	12.07	64.70
98	124	283	2,392
307	540	2,498	12,407
405	664	2,781	14,799
187	267	1,255	6,816
22	35	49	449
61	108	300	1,744
66,300	42,549	147,187	1,319,590
1,309.2	1,245.1	1,283.4	xxx
25.2	23.1	41.4	xxx
1,304.2	1,240.1	1,277.4	xxx
40	50	180	xxx
Veg.	Veg.	Veg.	xxx
4	2	2	xxx
80	80	79	xxx
1.00	1.00	5.25	xxx
5.64	8.20	8.20	xxx
3.47	5.81	5.68	xxx
2.8	5.5	5.7	xxx
28	270	1,044	xxx
1,304.9	1,242.2	1,279.6	xxx
8.24	14.1	14.1	xxx
5.85	11.49	11.34	xxx
6.5	9.4	10.4	xxx
344	1,280	6,300	xxx
1,306.9	1,245.1	1,283.4	xxx
17.7	25.3	120.7	xxx
35.4	50.6	241.4	xxx
0.94	0.83	0.40	xxx
0.10	0.09	0.04	xxx
1.04	0.92	0.44	xxx
3.25	4.00	3.88	xxx
4.05	5.10	4.11	xxx
a	b	b	xxx

TABLE 4 - ANNUAL COST

Turkey Creek Watershed, Kansas

(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Total
Structural Measures	66,300	5,200	71,500

1/ Amortized at 3 1/8 percent interest for a period of 50 years, base price 1964

2/ Operation and maintenance costs for structures were computed at .44 percent of construction cost estimate, long term base price. Operation and maintenance costs for channel improvement were computed as a separate item, spraying every 2 years and dislodging any drifts that may occur.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Turkey Creek Watershed, Kansas

(Dollars)1/

Item	Estimated Average Annual Damage		Damage Reduction Benefits
	Without Project	With Project	
Floodwater			
Crop and Pasture	128,800	49,200	79,600
Other Agricultural	17,600	6,000	11,600
Road and Bridge	23,600	8,700	14,900
Subtotal	170,000	63,900	106,100
Erosion			
Flood Plain Scour	4,300	2,500	1,800
Indirect	18,100	6,700	11,400
Total - On Project	192,400	73,100	119,300

1/ Price base - long term projected prices

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Turkey Creek Watershed, Kansas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/						Average Annual Costs 2/	Benefit Cost Ratio
	Flood Prevention					Total		
	Damage Reduction 3/	More Intensive Land Use	Changed Land Use	Secondary	Benefits Outside Watershed			
Structural Measures	96,800	13,600	6,400	13,900	2,200	132,900	71,500	1.9:1

1/ Price base - long term projected price
2/ From table 4
3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $24,500 annually

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INVESTIGATIONS AND ANALYSIS

COOPERATION IN PLANNING

General

Some of the engineering phases of watershed planning were accomplished with funds provided by the State of Kansas. These funds were utilized through an engineering contract between the Soil Conservation Service and Bucher and Willis, Consulting Engineers, Salina, Kansas. All other technical services were provided by the Soil Conservation Service.

Forestry

A Forestry Work Plan was developed by the District Extension Forester, Kansas State University, Manhattan, Kansas, through cooperative agreement with the Forest Service. The contents of the forestry plan have been included in the watershed plan.

PROJECT FORMULATION

Formulation of the structural system of this plan was accomplished jointly by the Soil Conservation Service and the Watershed District. Probable unit benefit per square mile of area controlled by reservoirs in each subarea was developed and was graphically presented. These benefits were developed by evaluating a complete range of possible area control by floodwater retarding structures. All possible structures were located which were physically feasible and had a chance of economic justification. Costs were estimated for approximately 32 structures in this study. From this information 19 reservoirs were selected for further study. Based on detailed surveys and cost estimates five of these sites were eliminated, two sites were moved and one site was added. This resulted in the final plan of 15 floodwater retarding reservoirs.

Channel improvement in the lower five reaches was planned to supplement the control by structures. The combination of structural measures gives an adequate level of protection for all reaches.

ENGINEERING

Surveys

Vertical control surveys were run throughout the watershed with permanent bench marks established within 0.5 mile of each structure site and each valley cross section. 96 permanent bench marks were set and referenced to mean sea level datum. 130 valley cross sections were surveyed by field crews. Sufficient readings were made to define the topography along each valley cross section, to locate all crop

boundaries and changes in the roughness factor, to locate all roads, fences, and other objects along the cross sections, and to define the shape of the channel section.

Topographic maps of the structures were made by Kelsh plotter. The maps were developed from aerial photographs with an approximate scale of 1" = 815'. A maximum contour interval of 4 feet was used. Contour lines were projected onto a photographic background providing a final map with good detail. Storage capacities were determined from the topography maps from which stage-storage curves were developed. Embankment quantities were calculated from centerline profiles. Accuracy of the Kelsh survey was verified by checking approximately 15 percent of the topographic maps.

Structure Design and Cost Estimates

Fifteen floodwater retarding structures are planned with two stage principal spillways. Two stage inlets are used because small release rates and relatively short drawdown times were desirable. On all structures in flat terrain or with a drainage area exceeding two square miles the first stage is set at the elevation of 90 percent of the 50-year sediment accumulation. On other structures the first stage is set at the elevation that provides the necessary sediment storage in the reservoir. The second stage inlet was planned at the elevation that provided a 5-year detention storage. The crest of the emergency spillway was planned to provide detention storage equal to or greater than that needed for the 25-year frequency storm. The freeboard hydrograph was routed through all structures with the maximum elevation equal to or less than the elevation of the top of the dam. A minimum emergency spillway size of five feet deep by forty feet wide was used. Structural data for each site is shown in table 3.

Trees and drift piles were counted in several sections and an estimate was made of the cost of clearing and grubbing for channel improvement. It was determined that new channel "n" values would vary from .060 to .080. An "n" value of .080 was used for evaluation purposes.

A cost estimate was calculated for each structure. Quantities of each item were based on surveyed data. Unit costs reflecting current bid prices for the different bid items were used to arrive at the total construction cost of each structure. Contingencies were calculated at 12 percent of the engineer's estimate. Installation services costs were calculated as a percent of construction costs. Easements and rights-of-way costs were calculated for each site using values per acre for cropland and pastureland agreed to by the sponsors. Structure cost data is tabulated in table 2.

HYDROLOGY AND HYDRAULICS

The watershed was divided into 13 subwatershed areas. Evaluation reaches were selected to coincide with the subwatershed area limits. For location see project map.

Hydrologic soil-cover complex numbers were developed for each subwatershed area for present and future watershed conditions. Future watershed conditions exist when the land treatment and cover measures outlined in this plan are established.

Rainfall frequency was obtained from United States Weather Bureau Technical Paper Number 40.

To obtain the relation of rainfall to runoff, the procedure as outlined in Chapter 3.10 National Engineering Handbook, Section 4, Hydrology, Supplement A, was followed. A factor of 4 was used for conversion of annual flood plotting positions to partial duration plotting positions. The frequency versus volume runoff relationship was developed for the needed range of hydrologic soil-cover complex numbers.

The relationship between discharge and inundation was based on 130 valley and channel cross sections. Plan profile sheets were developed relating cross sections vertically to mean sea level datum and using aerial photography for horizontal control. These profiles showed the channel bottom, flow line, bank line, and at least four discharges.

The Step Method as described in National Engineering Handbook, Section 4, Supplement A, Chapter 3.14 was used to make calculations for the hydraulics of the flood plain. A range of discharges was considered from below non-damage flow to above the 100-year frequency.

The relationship of discharge to area of inundation by depth increments was developed for each reach by combining data for all cross sections within each reach.

The relation of unit volume runoff to discharge was developed by floodrouting using Wilson's method. Triangular hydrographs, representing the unit volume of runoff from each subwatershed, were developed by the composite method with storm distribution from U. S. Weather Bureau Technical Paper 40. Floodrouting determined the discharge for a unit volume of runoff for each evaluation reach. This determination was made for present conditions, future land treatment conditions, future land treatment conditions with various percentages of each subwatershed controlled by floodwater retarding structures, future land treatment conditions with the 15 structure system, and future land treatment conditions with the 15 structure system plus channel improvement. This gave the discharge-

volume runoff relations for each evaluation reach considering a 0 to maximum percent range of area controlled by reservoirs and with the structural system presented in this plan. Frequency discharge relationships were tabulated for each of the above conditions.

A determination was made of the frequency of two historical storms which occurred in the watershed in 1951 and 1961. This was accomplished by securing high water marks for these storms and plotting them on the water surface profiles. This made it possible to determine the discharge of the actual storm at each reach. The discharge-frequency curve and the above discharges determined the frequency of the two storms at each reach.

Floodwater retarding structure release rates were established considering downstream channel capacities. Two stage release rates are planned in all structures. Combined maximum release rates will not exceed channel capacity. Individual structure release rates are shown in table 3.

The floodwater detention storage volume was determined by procedures in SCS Technical Release Number 10, modified to include effect of a saturated soil condition on incremental rainfall after the first day's precipitation. Storms used in connection with this procedure were taken from Weather Bureau Technical Paper No. 40. The volume for flood storage up to the second stage was computed using 5-year frequency storms. The total volume for floodwater storage was computed using 25, 50, or 100 year frequency storms depending on structure hazard class.

Dimensions of the emergency spillways were determined by floodrouting the storms indicated in SCS Engineering Memorandum No. 27 by the method outlined in Lincoln E&WPU Memorandum No. 2. Emergency spillways will exceed minimum criteria as established by the State of Kansas.

GEOLOGIC INVESTIGATIONS

Sedimentation in Reservoirs

Sediment rates and volumes were determined by sedimentation surveys made on existing reservoirs in the watershed area. The range method was used to determine sediment volume accumulated in each reservoir. Equipment used included survey instruments, boat, cable and meter, spud bar, and sounding bell.

Delta deposits were measured at 0 to 12 percent of the total sediment volume.

The significant sediment production factors of soil type, slope of the land, land use, and type of erosion were mapped on the drainage area above each surveyed reservoir. Sediment rates were computed for each reservoir and the variations in the sediment rates were equated to the difference in the sediment producing factors of the drainage areas.

Sediment rating curves were developed from the above computations. These curves show sediment in acre feet per square mile per year versus drainage area size. Curves were plotted for a range of sediment producing factors.

Sediment producing factors of the drainage areas above floodwater retarding structures were mapped and compiled. Sediment yield to each reservoir was read from sediment rating curves. A minimum of 10 percent was added above the sediment pool for delta deposition on reservoirs having a drainage in excess of two square miles.

Flood Plain Scour

The extent and severity of sheet scour and channel scour resulting from floods on the flood plain were determined. Scour areas were mapped in the field on aerial photographs. The degree of damage was based on the loss of productivity as compared with the unaffected parts of the field. Information derived from interviews with work unit personnel, soil scientists, and farmers aided in assembling land damage information.

Sheet and channel erosion was tabulated in acres with the percent of damage by evaluation reaches. Only eroded areas affected by upstream runoff were considered.

Future scour erosion in the next 50 years was estimated without the program for each reach. Future damage was based on soil type, present soil depth on the eroded areas, and the annual rate of erosion.

A recovery period for each reach in years was established from the amount of damage, soil type, and length and number of crop rotations required for potential recovery. The potential recovery of soil productivity without floods depends primarily on the capability class of the soil and the present soil depth. Affected areas having soil with 36 inches or more of depth and in Class I or II are considered capable of full recovery. Other classes of land with less depth of soil were considered to recover partially as compared to original productiveness.

Dam Sites

A geologic investigation was conducted at each proposed dam site. The work was accomplished by field observation, use of existing geologic maps, surveying instruments, and hand and power augers. The structural geology report includes a centerline profile with geologic conditions of each dam site, borrow areas shown on topographic maps, and geologic summary sheets.

Significant geologic features that might influence design or construction of a structure were investigated. A limited number of test holes on the centerline were used to determine the stability of the

foundation. The amount of stripping and the depth of core trench were determined from the geologic summary for each structure.

The recommended location of the principal spillway was based on density of the foundation, amount of excavation, length of conduit, and alignment of the pipe outlet with the stream channel. Materials to be excavated from the emergency spillway were presented in quantity and their potential use.

All soils investigated were classified by the Unified Soil Classification System.

ECONOMIC INVESTIGATIONS

The Frequency Method as described in Chapter 3 of the Economics Guide was followed in determining average annual floodwater damages under future conditions with and without the project. Thirteen subwatersheds used in the hydraulic and hydrologic computations were retained as evaluation reaches.

Basic data necessary for determining damages was collected by personal contacts with farm operators, township and county officials, and with local agricultural technicians. Remaining damages were computed by types in each of the evaluation reaches based on future conditions of land treatment with a range in percent of drainage area controlled by reservoirs and with formulated works of improvement in place. Benefits were computed for more intensive use and changed land use under these same conditions.

Floodwater damage to crops reflects net loss in income for the 100-year storm series. It was computed by determination of acres of cropland flooded and their depths of inundation. A composite acre of flood plain use was determined by interviews with farm operators and checked by field reconnaissance.

Average crop yields for the area, adjusted to flood-free conditions, using judgment of farm operators and agricultural technicians familiar with the area, were used in the evaluation. A different composite acre was developed in a similar manner for use in determining the benefit attributable to more intensive use and changed land use. The composite acres of crops grown under future conditions with and without the project on the flood plain and their flood-free yields follows:

Crops	Percent	Flood-Free Yield
Wheat	25	30 Bu.
Corn	35	40 Bu.
Grain Sorghum	5	40 Bu.
Alfalfa	15	4 Ton
Forage Sorghum	3	12 Ton
Oats	2	35 Bu.
Pasture	2	10 AUM
Timber	13	--

Crops	More Intensive Use Percent	Flood-Free Yield
Wheat	25	33 Bu.
Corn	35	45 Bu.
Grain Sorghum	5	45 Bu.
Alfalfa	15	4 Ton
Forage Sorghum	3	15 Ton
Oats	2	40 Bu.
Pasture	2	10 AUM
Timber	13	--

Net value of the composite acre was weighted using lower values for scour areas. Damageable values by depth increments were adjusted to reflect weighted values.

A percent loss from each crop was determined considering depth of inundation and month of flooding. Percent damage was used to determine damage for the composite acre. Rates of damage thus developed were weighted to allow for monthly distribution of flood producing storms. This adjustment was made to account for differences in flood damage that results during different periods of plant growth. The weighted rate was multiplied by acres inundated by selected discharges. A dollar damage versus discharge curve was developed to provide a monetary value for each storm discharge in the 100-year storm series.

Damage schedules were obtained from 40 to 60 percent of the landowners and operators of the flood plain area in each evaluation reach and the values expanded to 100 percent. The specific storms for which damage information was obtained were a major storm in June 1951 and a minor storm in May 1961. Flood damage information tabulated on the damage schedules includes other agricultural damages such as losses of livestock, machinery, and stored grains, removal of debris, and damage on private roads, channel crossings, and fences.

Road and bridge damages were based on information obtained from the county engineer's office showing their repair or replacement costs. Road damages were computed as dollar damage per foot by depth increments of inundation for various types of road surfaces within the watershed. Bridge damages were estimated for individual bridges by various discharges. Road and bridge damages were then combined in each evaluation reach and dollar damage versus discharge curves were plotted. These curves were then applied to the 100-year storm series.

Indirect damages such as depreciation of property in the flooded areas, loss of time, and additional expenses of operators used in repair and clean-up which would normally be used in a productive operation, and additional distances driven by rural mail carriers, school busses, and farmers because of flooded roads were considered. The indirect damages were computed at 10 percent of the crop and other agricultural damages and 15 percent of road and bridge damage.

The estimate of damages to land due to flood plain scour was derived from data gathered in the field by the geologist regarding acres damaged, severity of damage, and period and degree of recovery due to the installed program. Economic evaluation was based on the net value of the composite acre. Changes in net income due to scour damage was evaluated at 6 percent interest rate.

Off-project damage area considered was the Smoky Hill River flood plain from the junction of the Smoky Hill River and Turkey Creek to Junction City, Kansas. Benefits to the Smoky Hill River flood plain were determined in a meeting with the Corps of Engineers. Off-project benefits were determined by reducing remaining damage to the Smoky Hill flood plain by a percentage equal to the percent of the Smoky Hill drainage area controlled by Turkey Creek structures. Each square mile of control on Turkey Creek benefited the Smoky Hill flood plain by an average annual amount of $34.

It was estimated that 641 acres of wooded and pastureland in localized areas adjacent to the streambank will be cleared and used for crop production. This determination was supported by interviews with farmers, measurement of aerial photos, and from past experiences within the pilot watersheds. Farm owners and operators reported, where topography allows and where expected frequency of damaging floods can be substantially reduced, a change of land use will occur. Increased damages from remaining floods were computed and deducted from the increase in production due to land enhancement.

Secondary benefits were computed on two conditions. The value of local secondary benefits stemming from the project was determined as 10 percent of the direct primary project benefits. The second condition

was the value of local secondary benefits induced by the project. These values were determined as 10 percent of the increased costs that primary producers will incur in connection with increased production. Indirect benefits were excluded from consideration in computing secondary benefits. These benefits were used in project justification and are included in the programs over-all B:C ratio.

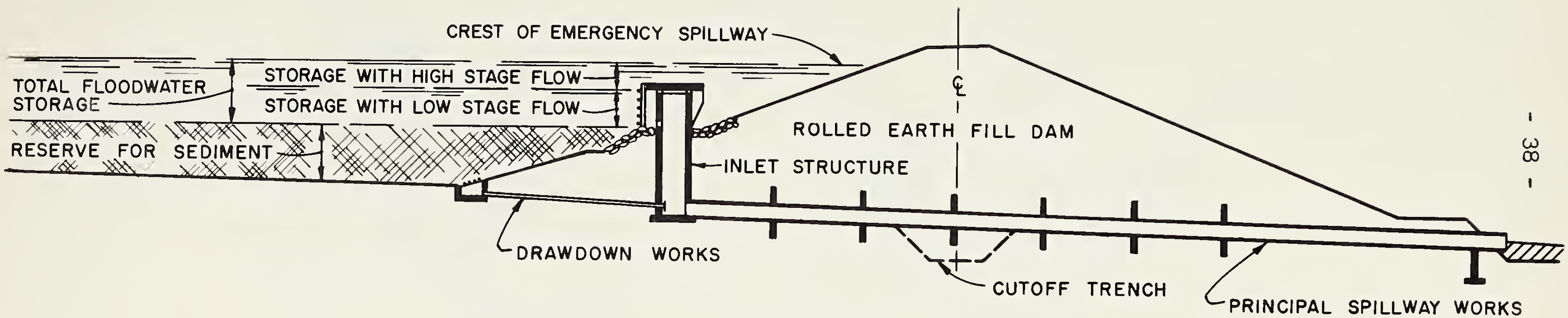
The cost of easements and rights-of-way was based on the value of cropland and pasture as determined by the watershed directors. These were $125 per acre for upland cropland and $100 per acre for pasture. Land costs for sediment pool areas were based on 100 percent of the land value, dam and spillway areas were based on 75 percent of the land value, and detention areas were based on 50 percent of the land value. The value of easements and rights-of-way were compared with the value of production lost in the structure sites. Procedures followed were those shown in Chapter 3 of the Economics Guide for Watershed Protection and Flood Prevention. It was found that easements and rights-of-way costs were greater than the value of production lost in the structure sites. Therefore, other economic costs were not considered.

All monetary evaluation for benefits were based on long-term projected prices, using "Agricultural Price and Cost Projections" Agricultural Research Service, dated September 1957. Construction costs as experienced in Kansas on P.L. 566 projects were up dated to the year 1964 and were used to estimate the construction costs of structural measures. Operation and maintenance costs were computed for floodwater retarding structures at 0.44 percent of construction cost. The method used for computing these costs was developed by the Lincoln Engineering and Watershed Planning Unit. It is based on the principle that the relative probability of need for major type repairs decreases as the number of structures increases. Federal and local costs were amortized at 3 percent interest rate for a period of 50 years.

Figure 2

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TYPICAL FLOODWATER RETARDING STRUCTURE WITH TWO-STAGE PRINCIPAL SPILLWAY



CROSS SECTION OF DAM ON ℄ OF PRINCIPAL SPILLWAY

NOTES:

1. LOW STAGE FLOWS TO BE REGULATED BY AN ORIFICE.
2. FOR INDIVIDUAL STRUCTURE DATA SEE TABLE 3.
3. EMBANKMENT AND FOUNDATION DESIGN FEATURES NOT SHOWN.

USDA-SCS LINCOLN NEBR 1964

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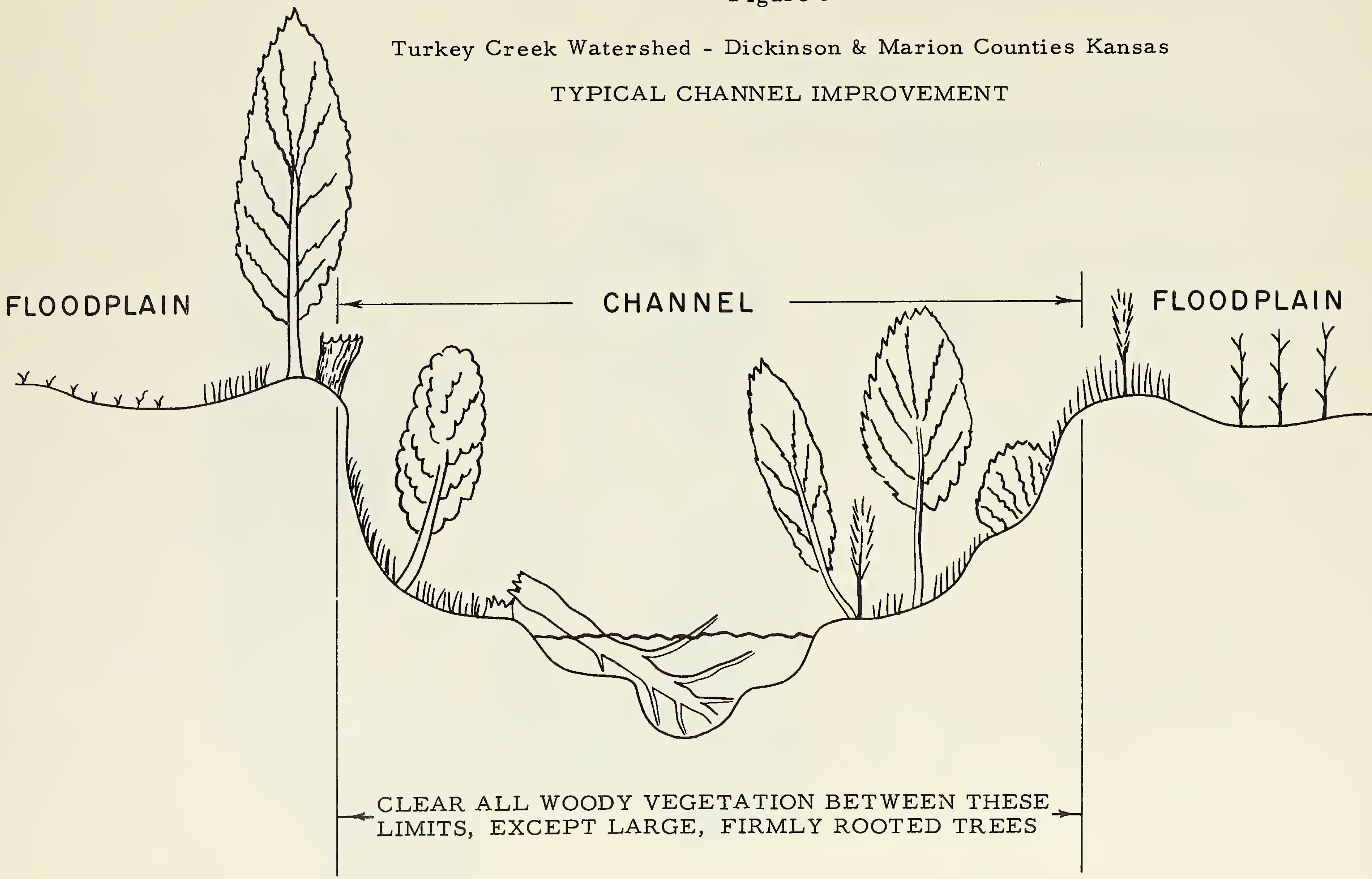
7-64

Figure 3

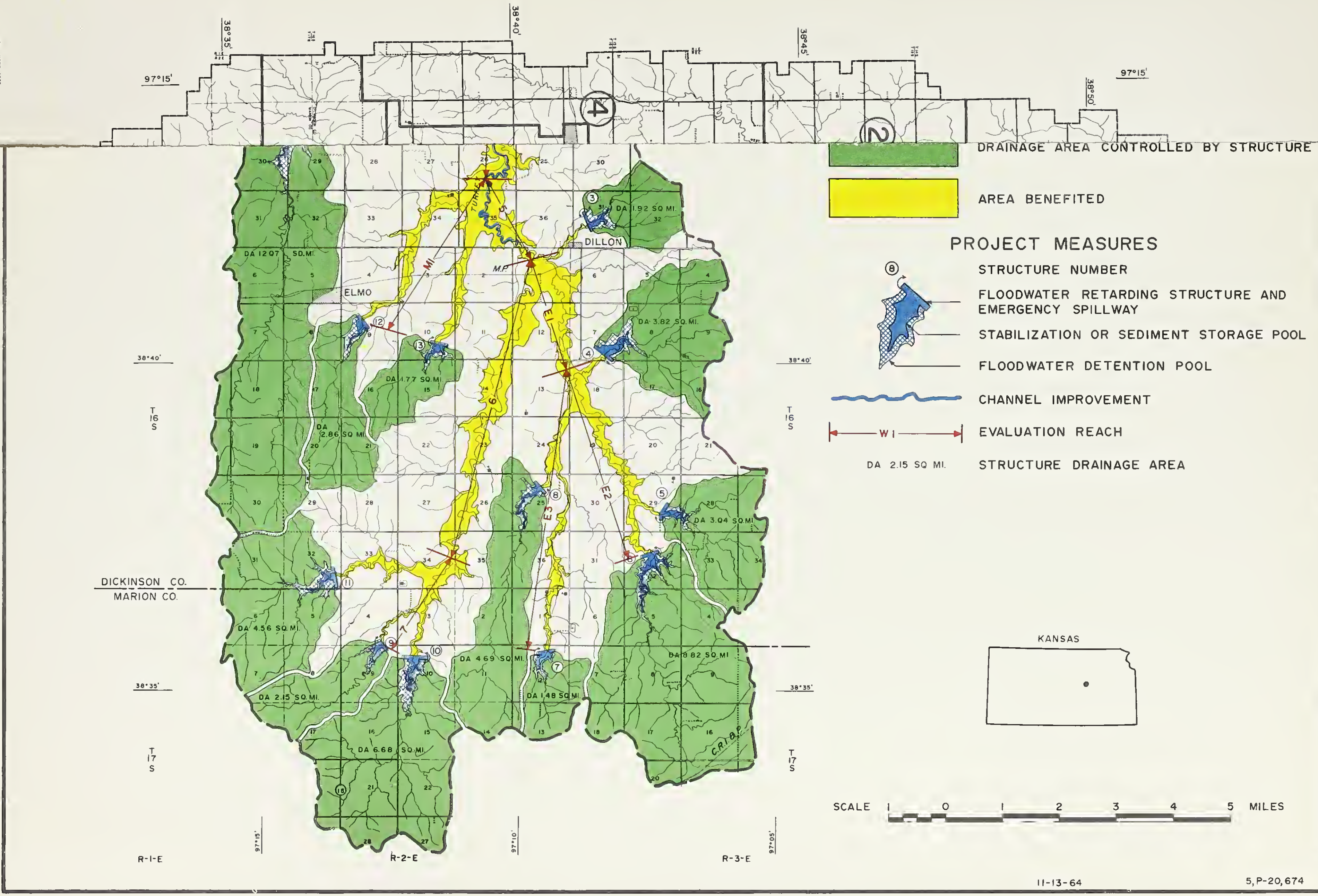
Turkey Creek Watershed - Dickinson & Marion Counties Kansas

TYPICAL CHANNEL IMPROVEMENT



USDA-SCS-LINCOLN, NEBR. 1965

5,L-20,890



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5, P-20,674

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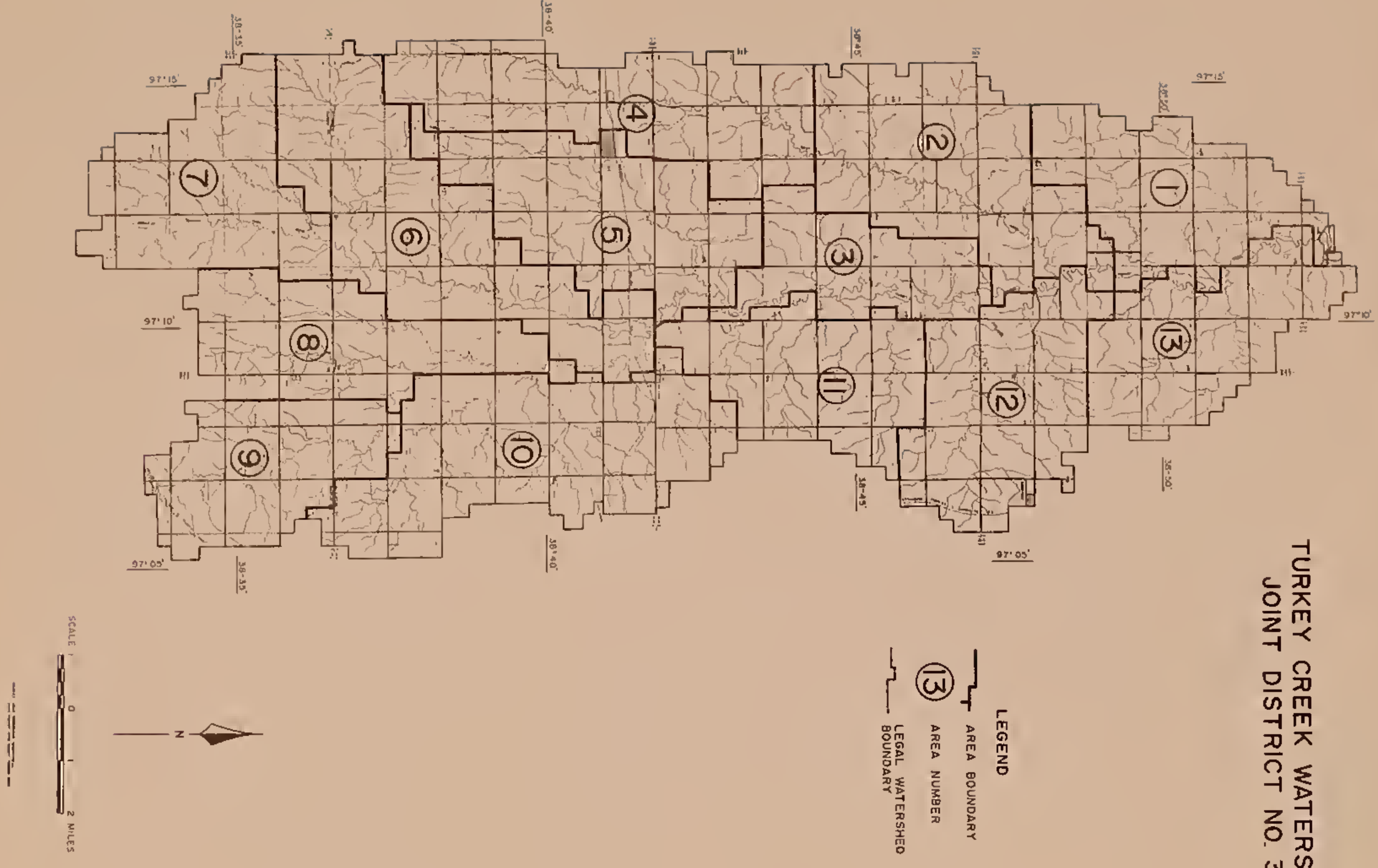
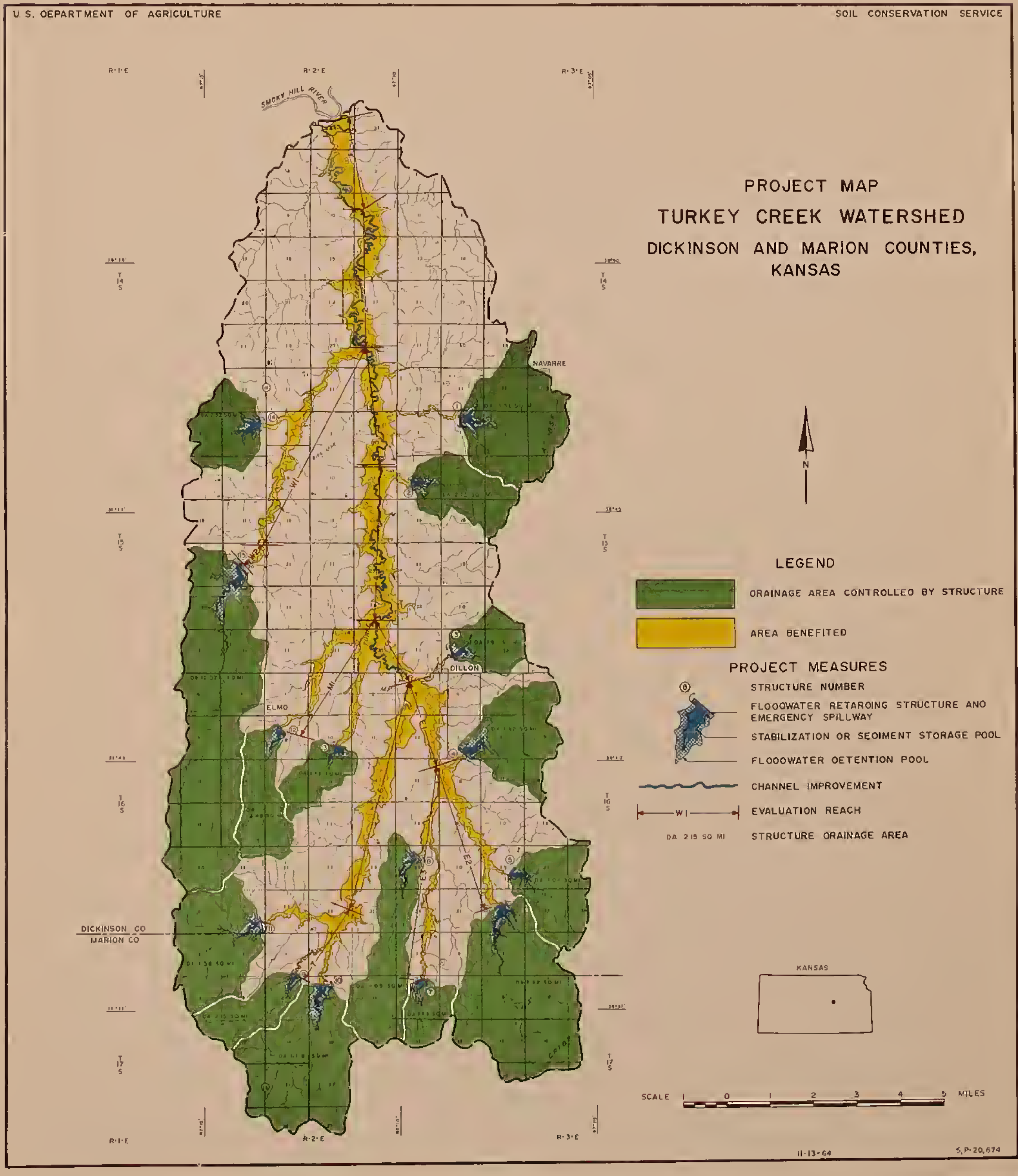


TURKEY CREEK WATERSHED
JOINT DISTRICT NO. 32



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